

CLAIMS

What is claimed is:

1 1. A method for determining a parameter proportional to the cardiac stroke
2 volume of a subject comprising:

3 sensing an input signal that is proportional to arterial blood pressure;
4 calculating the standard deviation of the input signal over a measurement
5 interval; and

6 calculating an estimate of the cardiac stroke volume as a function of the
7 standard deviation of the input signal.

1 2. A method as in claim 1, further comprising:

2 measuring the heart rate of the subject; and
3 estimating current cardiac output of the subject by calculating the product of the
4 heart rate and the standard deviation and scaling the product by a calibration constant.

1 3. A method as in claim 2, further comprising:

2 measuring a calibration cardiac output value; and
3 calculating the calibration constant as the quotient between a calibration cardiac
4 output estimate and the product of the heart rate and the standard deviation.

1 4. A method as in claim 1, further comprising sensing the input signal non-
2 invasively.

1 5. A method as in claim 1, in which the measurement interval extends over
2 more than one cardiac cycle.

1 6. A method as in claim 5, in which the measurement interval is a plurality of
2 cardiac cycles.

1 7. A method as in claim 5, further comprising:
2 calculating a component standard deviation value of the input signal for each of
3 a plurality of measurement intervals;
4 computing a composite standard deviation value as an average of the
5 component standard deviation values; and
6 using the composite standard deviation value in calculating the estimate of the
7 cardiac stroke volume.

1 8. A method as in claim 5, further comprising:
2 for each of a plurality of cardiac cycles, calculating a mean pressure value; and
3 adjusting the measurement interval as a function of change in the mean
4 pressure value.

1 9. A method as in claim 5, further comprising high-pass filtering the input
2 signal before the step of calculating the standard deviation.

1 10. A method as in claim 1, in which the input signal is a measurement of the
2 arterial blood pressure.

1 11. A method as in claim 10, further comprising:
2 determining a maximum value and a minimum value of the arterial blood
3 pressure; and
4 calculating the standard deviation as a function of the difference between the
5 maximum and minimum values.

1 12. A method as in claim 1, in which the step of calculating the estimate of the
2 cardiac stroke volume as a function of the standard deviation of the input signal
3 comprises calculating the product of the standard deviation and a calibration factor

1 13. A method for determining cardiac stroke volume of a subject comprising:
2 sensing arterial blood pressure;
3 converting the sensed arterial blood pressure to a pressure signal;

4 calculating the standard deviation of the pressure signal over a measurement
5 interval;

6 calculating an estimate of the stroke volume as a function of the standard
7 deviation of the pressure signal.

1 14. A method as in claim 13, further comprising:
2 measuring the heart rate of the subject; and
3 estimating current cardiac output of the subject by calculating the product of the
4 heart rate and the standard deviation and scaling the product by a calibration constant.

1 15. A method as in claim 14, further comprising:
2 measuring a calibration cardiac output value; and
3 calculating the calibration constant as the quotient between a calibration cardiac
4 output estimate and the product of the heart rate and the standard deviation.

1 16. A method for estimating cardiac output of a subject comprising:
2 sensing arterial blood pressure;
3 converting the sensed arterial blood pressure to a pressure signal;
4 calculating the standard deviation of the pressure signal over a measurement
5 interval;
6 calculating an estimate of stroke volume as a function of the standard deviation of
7 the pressure signal;
8 measuring the heart rate of the subject; and
9 estimating current cardiac output of the subject by calculating the product of the
10 heart rate and the standard deviation and scaling the product by a calibration constant.

1 17. A system for determining a parameter proportional to the cardiac stroke
2 volume of a subject comprising:
3 a sensor located in or on the body of the subject and generating a sensor signal
4 that is proportional to arterial blood pressure;
5 conversion circuitry that receives the sensor signal and converts it to an input
6 signal;

7 a processing system that receives the input signal and that includes processing
8 modules for calculating the standard deviation of the input signal over a measurement
9 interval and for calculating an estimate of the cardiac stroke volume as a function of the
10 standard deviation of the input signal; and

11 a display for presenting the estimate of the cardiac stroke volume to a user.

1 18. A system as in claim 17, further comprising a heart rate monitor
2 measuring the heart rate of the subject;
3 the processing system estimating current cardiac output of the subject by
4 calculating the product of the heart rate and the standard deviation and scaling the
5 product by a calibration constant.

1 19. A system as in claim 17, further comprising a high pass filter connected
2 between the sensor and the processing system.

1 20. A system as in claim 17, in which the sensor is a direct blood pressure
2 sensor.

1 21. A system for determining a parameter proportional to the cardiac stroke
2 volume of a subject comprising:

3 a sensor located in or on the body of the subject and generating a sensor signal
4 that is proportional to arterial blood pressure;

5 conversion circuitry that receives the sensor signal and converts it to an input
6 signal;

7 a processing system including computer-executable code for calculating the
8 standard deviation of the input signal over a measurement interval; and for calculating
9 an estimate of the cardiac stroke volume as a function of the standard deviation of the
10 input signal; and

11 a display for presenting the estimate of the cardiac stroke volume to a user.

1 22. A system as in claim 21, further comprising a heart rate monitor
2 measuring the heart rate of the subject, the processing system further including

3 computer-executable code for estimating current cardiac output of the subject by
4 calculating the product of the heart rate and the standard deviation and scaling the
5 product by a calibration constant.

1 23. A system as in claim 22, further comprising a calibration system
2 measuring a calibration cardiac output value, the processing system further including
3 computer-executable code for calculating the calibration constant as the quotient
4 between a calibration cardiac output estimate and the product of the heart rate and the
5 standard deviation.

1 24. A system as in claim 1, in which the sensor is non-invasive.

1 25. A method for determining cardiac stroke volume of a subject comprising:
2 sensing arterial blood pressure;
3 converting the sensed arterial blood pressure to a pressure signal;
4 detecting a maximum and a minimum pressure value over a measurement
5 interval; and
6 calculating an estimate of the stroke volume as a function of the difference
7 between the maximum and a minimum pressure values.

1 26. A method for determining cardiac stroke volume of a subject comprising:
2 sensing arterial blood pressure;
3 converting the sensed arterial blood pressure to a pressure signal;
4 detecting a maximum value of the first time derivative of the pressure value
5 during a measurement interval; and
6 calculating an estimate of the stroke volume as a function of the maximum value.

1 27. A method for determining cardiac stroke volume of a subject comprising:
2 sensing arterial blood pressure;
3 converting the sensed arterial blood pressure to a pressure signal;
4 detecting a minimum value of the first time derivative of the pressure value
5 during a measurement interval; and

6 calculating an estimate of the stroke volume as a function of the minimum value.

1 28. A method for determining cardiac stroke volume of a subject comprising:
2 sensing arterial blood pressure;
3 converting the sensed arterial blood pressure to a pressure signal;
4 detecting a maximum value and a minimum value of the first time derivative of
5 the pressure value during a measurement interval; and
6 calculating an estimate of the stroke volume as a function of the maximum and
7 minimum values.

1 29. A method for determining cardiac stroke volume of a subject comprising:
2 sensing arterial blood pressure;
3 converting the sensed arterial blood pressure to a pressure signal;
4 determining the heart rate of the subject;
5 determining the amplitude of a spectral component of the pressure signal for a
6 frequency corresponding to a multiple of the heart rate;
7 calculating an average value of the pressure signal; and
8 calculating an estimate of the stroke volume as a function of the ratio of the
9 amplitude of the spectral component and the average value of the pressure signal.